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Inventor :

ISHIZAKA ICHIRO

TAKEFUSHI NORIYUKI

AOYAMA YUZURU

APPARATUS FOR FABRICATING LIQUID CRYSTAL PANEL

[Abstract]

PROBLEM TO BE SOLVED: To realize rapid and uniform conduction of heat from a surface board to the whole substrate.

SOLUTION: The surface board 1 is formed into one body from a heat- resistant material having high rigidity and an almost same coefficient of thermal expansion as that of substrates A, B, so that it maintains its form without causing deformation by heat. A heating means 2 and a cooling means 3 are embedded as two-dimensionally and densely arranged near to each other in the surface board, so that the whole pressurizing face 1a of the surface board 1 is uniformly and rapidly heated by operating the heating means 2 and is rapidly cooled by operating the

cooling means 3.

[Claims]

1. An apparatus for fabricating a liquid crystal display panel in which two substrates A and B which are bonded with high precision are set on a base plate 1, the substrates A and B are pressurized with the same high precision until a predetermined gap is formed therebetween, the substrates A and B are heated by a heating unit 2 of the base plate 1, and a thermosetting adhesive C between two substrates A and B is hardened, wherein the base plate 1 is formed of a heat resistant material having a heat expansion rate as same as that of the substrates due to its high rigidity, and the heating unit 2 and a cooling unit 3 are buried in the base plate 1 to be adjacent to each other in a dense state on a plane.

2. The apparatus of claim 1, wherein the linear heating units 2 and linear cooling units 3 are alternately arranged in the middle of the upper and the lower portions of the base plate 1.

[Title of the Invention]

APPARATUS FOR FABRICATING LIQUID CRYSTAL PANEL

[Detailed Description of the Invention]

[Field of the Invention]

The present invention is related to an apparatus for fabricating a liquid crystal display panel used in a liquid crystal display device, and more particularly, an apparatus for fabricating a liquid crystal display panel in which two substrates laminated with high precision are set on a base plate and pressurized with the same high precision downwardly until a predetermined gap is formed, the pressurized substrates are heated by a heating unit of the base plate, and a thermosetting adhesive between both the substrates is hardened

[Description of the Prior Art]

As disclosed in Patent No. 2934438 as such apparatus for fabricating a liquid crystal display panel in the prior art, for instance, a base plate is divided into an upper member and a lower member, wherein a cooling unit is buried in the upper member and a heating unit is installed in the lower member, which indicates that the heating unit of the lower member is operated in a state that the substrate is pressurized. That is, the substrate is heated by a heat conduction from the lower member, positioning the upper member between the substrate and the lower member. When performing a cooling after the heating operation, the lower member is divided from the upper member, thereby rapidly cooling the upper member.

[Problems to be Solved by the Invention]

However, in this prior art apparatus for fabricating a liquid crystal display panel, because heat is delivered to the substrate from the lower member via the upper member, positioning a bonded surface between the upper and lower members, if the bonded surface between the upper and lower members are perfectly leveled and thusly their whole surfaces are surface-contact therewith, the entire upper member and substrate can uniformly be heated. However, it is difficult to perform the leveling perfectly for the upper and lower bonded surface, which results in increase of fabrication cost. In particular, if the upper and lower members of the base plate should be larger as the substrate is larger, it is difficult to perfectly level the upper and lower bonded surface. As a result, when some concavo-convex is generated on this bonded surface, a partially-contact portion and a non-contact portion are generated, whereby heat is first conducted from the partially-contact portion and then to the lower member later. Accordingly, the entire surface of the substrate is hard to be heated uniformly, and a time for the heat transfer is required to thusly reduce a heat response, which results in difficulty in a temperature control.

The present invention according to claim 1 aims to enable a uniform heat conduction over the substrate rapidly from the base plate. The present invention according to claim 2 aims to perfectly prevent deformation of the base plate by a change of a temperature in addition to the object of the present invention according to claim 1.

[Means for Solving the Problem]

To solve those objects, the present invention according to claim 1 aims to

form a base plate which is made of a heat resistant material having a heat expansion rate as same as that of each substrate due to its high rigidity to thus be integral with the substrate, and to bury a heating unit and a cooling unit in the base plate to be adjacent to each other as a dense state in a plane. The present invention according to claim 2 adds a construction, in which the heating unit and the cooling unit of a linear shape are alternately approached and arranged in the middle of upper and lower portions of the base plate, to the construction mentioned in the present invention according to claim 1.

[Operation]

In the present invention according to claim 1, as a base plate is formed of a heat resistant material having a heat expansion rate as same as that of each substrate due to its high rigidity to be integral with the substrate, the base plate may not be deformed by heat. A heating unit and a cooling unit are buried in the base plate to be adjacent to each other as a dense state in a plane. As a result, the entire surface of the base plate is quickly and uniformly heated by the operation of the heating unit, to thereafter be quickly cooled by the operation of the cooling unit. In the present invention according to claim 2, a construction in which the heating unit and the cooling unit of a linear shape are alternately approached and arranged in the middle of upper and lower portions of the base plate is added to the construction disclosed in claim 1, whereby an upper portion and a lower portion of the base plate have the same condition by positioning the heating unit and the cooling unit therebetween, which results in preventing a difference of temperature between the upper and lower portions of the base plate.

[Embodiment of the Invention]

Hereinafter, an embodiment according to the present invention will be explained with reference to attached drawings.

In these embodiments as illustrated in Figures 1 and 2, two glass substrates bonded with high precision in the air are set on a base plate 1 and an upper cover 4 descends to be contact with a sealant 5. As a result, a closed space 6 surrounded by the annular sealant 5 is formed between the base plate 1 and the upper cover 4. By decompression within the closed space 6, the upper cover 4 can be pressed downwardly by atmospheric pressure to thus pressurize the substrates A and B, positioning a buffer therebetween.

The base plate 1 is formed of a heat resistant material (e.g., carbon) having a heat expansion rate as same as that of each substrate A and B due to its high rigidity to be integral with the substrates A and B and is as thick as not simply deformed by heating using the heating unit 2 and cooling using the cooling unit 3 buried therein.

These heating unit 2 and cooling unit 3 are buried to be adjacent to each other as a dense state in a plane. In the embodiments as illustrated in Figures 1 and 2, in the middle of the upper and lower portions of the base plate 1, a plurality of the linear heating units 2 and the linear cooling units 3 are alternately adjacent to each other at a predetermined pitch (e.g., 50 to 60 mm) in a longitudinal direction to be respectively parallel with each other. A linear heater radiating heat by being conducted is used as the heating unit 2. A cooling pipe through which a coolant passes is used as the cooling unit 3.

Compared with the center portion of the base plate 1, an outer edge portion is easy to be cooled by being radiated. Hence, the temperature of the

heating unit 2 is set such that the heating temperature at the outer edge portion is higher than that at the center portion, and thus a uniform temperature can be maintained over a pressurized surface 1a of the base plate 1.

Furthermore, an annular sealant 5 such as O-ring is mounted on the pressurized surface 1a of the base plate 1, facing a pressurized surface 4a of the upper cover 4. By using an aligning unit (not shown) such as a frame positioned inside the annular sealant 5, for instance, two substrates A and B including a color filter and a TFT substrate having a desired pattern are set in position. A suction passage 1b is installed in the base plate 1 so as to be communicated with a space between the substrates A and B and the annular sealant 5. Air can be sucked and exhausted from the inside of the annular sealant 5 through this suction passage 1b.

In the substrates A and B, one substrate is coated with an adhesive C formed of thermosetting resin along such frame shape, a part of which is open as a liquid crystal injection hole C1, while a plurality of spacers D are spread over the other substrate. Thereafter, the two substrates A and B are aligned with high precision in the air to be bonded with each other. As illustrated in Figures 1 and 2, there is only one frame by the adhesive C. However, it is not limited thereto, but a plurality of frames of the adhesive C can be arranged between the substrates A and B if the two substrate A and B have large sizes.

On the other side, the upper cover 4 is formed of a rigid body such as carbon. The upper cover 4 is supported by a lifting device (e.g., a driving cylinder although not shown) to thus be reciprocated. Though, after the upper cover 4 descends to be contact with the annular sealant 5, a link of the lifting device is released and thusly the upper cover 4 can move up and down free.

A heating/cooling unit 7 is installed on a pressurized surface 4a of the upper cover 4. In order to make the heat of the heating/cooling unit 7 be maintained, the upper cover 4 is formed of a material having superior thermal resistance, or a heat insulator (not shown) interposes between the pressurized surface 4a of the upper cover 4 and the heating/cooling unit 7. In the embodiment, the heating/cooling unit 7 is formed by integrally laminating a plate heater radiating by being conducted and a metal plate having a plurality of cooling pipes therein through which a coolant passes.

A buffer 8 is fixed to the pressurized surface 4a of the upper cover 4 so as to cover the heating/cooling unit 7 and be contact with the substrates A and B. This buffer 8 is formed of such silicon foam rubber having good durability (more than 100°C) or a material having durability superior to the silicon foam rubber so as to harden the adhesive C between both the substrates A and B. A thickness of the buffer 8 is set such that when the pressurized surface 4a of the upper cover 4 is contact with the annular sealant 5, as illustrated in Figure 1(a), a end surface 8a is not contact with an upper end surface of both the substrates A and B, positioning a space therebetween. Furthermore, the thickness of the buffer 8 is set such that when the upper cover 4 could be pressurized downwardly by decompression within a closed space 6 surrounded by the annular sealant 5 in atmospheric pressure, as illustrated in Figure 1(b), the end surface 8a is contact with the upper end surface of the substrates A and B to thusly be compressed and deformed.

In the present invention, another buffer 8' smoother than the annular sealant 5 is installed at a circumferential portion of the pressurized surface 4a of the upper cover 4 facing the annular sealant 5. When the upper cover 4 could be

pressurized downwardly by the decompression within the closed space 6, the buffer 8' at the circumferential portion is compressed and deformed prior to the annular sealant 5. Thereafter, the end surface 8a of the buffer 8 is contact with the upper end surface of the substrates A and B to thusly be compressed and deformed. It is not limited to this, but since the upper cover 4 can be pressurized in the atmospheric pressure, if the end surface 8a of the buffer 8 is contact with the upper end surface of the substrates A and B within the range in which the annular sealant 5 is pressurized downwardly to thusly be compressed and deformed, a protrusion replacing the buffer 8' and formed of a rigid body can integrally be formed with the upper cover 4.

Next, an operation of this apparatus for fabricating the liquid crystal display panel will now be described. First, in the initial state, the base plate 1 maintains a temperature which does not affect on the adhesive C, for instance, under a temperature of 60°C to lift the upper cover 4. The substrates A and B are set on the base plate 1. After completing this setting, as shown in Figure 1(a), the upper cover 4 is lifted down by gravitation or driving a cylinder to be contact with the annular sealant 5. As a result, the closed space 6 surrounded by the annular sealant 5 is formed between the upper cover 4 and the base plate 1.

Afterwards, suction and exhaust are initiated from the suction passage 1b of the base plate 1, and the inside of the closed space 6 is decompressed. Thus, as shown in Figure 1(b), since the upper cover 4 is slowly pressurized downwardly in the atmospheric pressure, the end surface 8a of the buffer 8 is pressurized on the substrates A and B to be compressed and deformed. As a result, regardless of a plane of the pressurized surface 4a of the upper cover 4, the thickness between the pressurized surface 4a of the upper cover 4 and the substrates A and B can be

uniform. Therefore, it is possible to precisely pressurize the substrates A and B downwardly until a predetermined gap is formed therebetween, maintaining the two substrates A and B in a completely parallel state.

Residual air between both the substrates A and B, namely, the residual air within a liquid crystal sealing space C2 surrounded by the adhesive C is removed through the liquid crystal injection hole C1, which is open in a part of the adhesive C, according to the decompression of the closed space 6. Therefore, the residual air within the liquid crystal sealing space C2 does not act as a reverse force against the pressure of the substrates A and B, and thus the substrates can smoothly be pressurized down to the predetermined gap.

At the time point that the substrates A and B are pressurized down near the predetermined gap, the heating unit 2 of the base plate 1 and the heating/cooling unit 7 of the upper cover 4 are conducted. Afterwards, the temperature of the substrates A and B is uniformly increased to soften the adhesive C, thereby forming the predetermined gap. Thereafter, until the adhesive C is re-hardened, the temperature is controlled.

At this time, since the base plate 1 is formed of a heat resistant material having a heat expansion rate as same as that of each substrate due to its high rigidity to thus be integral with the substrate, the base plate 1 is not deformed by heat but its shape is maintained. As well, since a heating unit and a cooling unit in the base plate 1 are buried to be adjacent to each other as a dense state in a plane, the entire pressurized surface 1a of the base plate 1 is uniformly heated with a fast speed. Therefore, heat can uniformly be conducted over the entire substrates A and B from the base plate with a fast speed.

After the adhesive C is completely hardened, the suction and exhaust

through the suction passage 1b of the base plate 1 is stopped. Water flows into the cooling unit 3 of the base plate 1 and a cooling pipe of the heating/cooling unit 7 to cool the water. Thereafter, the upper cover 4 is lifted and the substrates A and B are carried out, and then the aforementioned operations are repeated.

Figures 3 and 4 show different embodiments of the present invention, respectively. In Figure 3, the heating unit 2 of the base plate 1 is not a plurality of linear heaters but plate heaters. The plurality of plate heaters are aligned in a middle of upper and lower portions of the base plate 1. Furthermore, at a certain side of the upper and lower portions, a plurality of cooling pipes are arranged as the cooling unit 3 at a predetermined pitch in a longitudinal direction. Such construction is illustrated in the embodiment of the Figures 3 and 4 are different from those of Figures 1 and 2, while other constructions thereof are the same as those shown in the embodiments of Figures 1 and 2.

Therefore, since a gap of a heating source is rarely generated in the embodiment of Figure 3 as compared with embodiments of Figures 1 and 2, the entire substrates A and B can be heated more uniformly and the structure thereof can be simplified as compared with the structure of arranging a plurality of linear heaters to thus advantageously reduce fabrication cost.

In Figure 4, the structure of the upper cover 4 is the same as the structure disposing a heater attaching reflection board 7' therein disclosed in Japanese Patent No. 2934438, and also the pressurized surface being contact with the substrates A and B is a flexible film 9 having a heat expansion rate as same as that of each substrate A and B, of which construction is different from that shown in the embodiments of Figures 1 and 2, and other constructions thereof are the same as those shown in the embodiments of Figures 1 and 2.

Therefore, as in the embodiments shown in Figures 1 and 2, in the embodiment of Figure 4, heat can also be conducted over the entire substrates A and B from the base plate 1 with a fast speed.

In those aforementioned embodiments, the substrates A and B are set on the base plate 1, and the closed space 6 is formed by descending the upper cover 4 to be contact with the annular sealant 5. The upper cover 4 can be pressurized in the atmospheric pressure by the decompression within the closed space 6, and accordingly the substrates A and B can be pressurized, positioning the buffer 7 between the substrates A and B and the upper cover 4. However, this is not limited thereto. That is, if the substrates A and B are pressurized downwardly until the predetermined gap is formed while heating the base plate 1 by the heating unit 2, and the thermosetting adhesive C between both the substrates A and B can be hardened, other structure may be available.

Furthermore, in the embodiments shown in Figures 1 and 2, the plurality of linear heating units 2 and linear cooling units 3 are respectively arranged to be parallel to each other. However, this is not limited thereto. The plurality of linear heating units 2 and linear cooling units 3 are respectively divided in upper and lower directions to make each of them cross in a plane.

[Effect of the Invention]

As aforementioned, in the present invention according to claim 1, the base plate is formed of a heat resistant material having a heat expansion rate as same as that of the substrates due to its high rigidity to be integral with the substrates, and accordingly the base plate can be prevented form being deformed by heat. In addition, the heating unit and the cooling unit are buried in the base plate to be

adjacent to each other with a dense state in a plane, and accordingly the entire pressurized surface of the base plate can uniformly be heated with a fast speed by driving the heating unit and then cooled with a fast speed by the cooling unit. As a result, heat can uniformly be conducted from the base plate over the entire substrates. Therefore, even if some concavo-convex is generated on the upper and lower bonded surfaces of the base plate, the entire surface of the substrate can uniformly be heated and heat response is superior to thereby easily control a temperature, compared with the related art in which a partially-contact portion is previously heat-conducted and the non-contact portion is heat-conducted later. This effect is obvious when the base plate is larger as the substrates are larger. Furthermore, compared with the related art in which the upper and lower bonded surfaces of the base plate are fabricated to be completely planed, the operation for fabricating the completely planed bonded surfaces is not required in the present invention, which results in remarkable reduction of the fabrication cost for the base plate.

In the present invention according to claim 2, in addition to the effect of the present invention according to claim 1, the upper portion and the lower portion of the base plate have the same condition by arranging the heating unit and the cooling unit therebetween, and thus a temperature difference between upper and lower portions of the base plate does not occur by heating and cooling, which results in completely preventing deformation of the base plate due to the change of temperature.

[Brief Description for the Drawing]

Figure 1 is a longitudinal sectional view showing an apparatus for

fabricating a liquid crystal display panel according to an embodiment of the present invention, wherein Figure 1(a) shows a state before decompression and Figure 1(b) shows a state when the substrates are pressurized by the decompression.

Figure 2 is a cross-sectional view taken along the line (2)-(2) in Figure 1(a).

Figure 3 is a longitudinal sectional view showing an apparatus for fabricating a liquid crystal display panel according to another embodiment of the present invention, which shows the state before decompression.

Figure 4 is a longitudinal sectional view showing an apparatus for fabricating a liquid crystal display panel according to the other embodiment of the present invention, which shows the state before decompression.

[Explanation for Reference Symbol]

A, B substrate, C adhesive, 1 base plate, 2 heating unit, 3 cooling unit